International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 02 | Feb 2021 www.irjet.net p-ISSN: 2395-0072

EFFECT OF WELD PARAMETERS ON TEMPERATURE, STRESSES, HARDNESS AND MICROSTRUCTURE OF DISSIMILAR AA7075 AND AA6065 FRICTION STIR WELDED JOINTS

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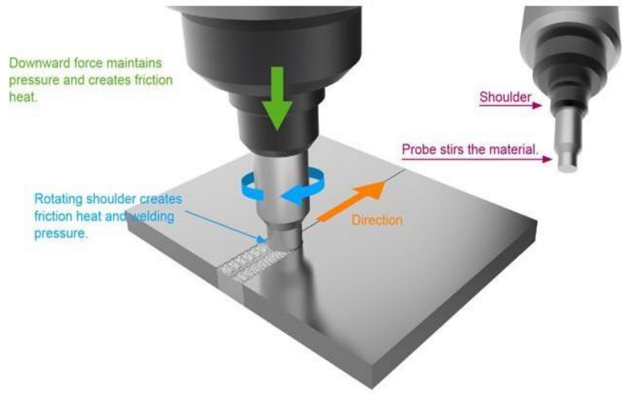
Abstract - *FEA analysis will be performed for friction stir welding of Aluminum alloy 7075 and AA6065 at different profiles using ANSYS. For the analysis the effects of different tool pin profiles on the friction stir welding will also be considered. Tool pin profiles are circular, square and taper. In this project, we are carried out experimentation at different tool pin profiles and work piece materials are Aluminum alloy 7075 and AA6065. Tool material is HCHCr (high chromium high carbon steel). In this project to evaluate the mechanical properties such as tensile strength, hardness and microstructure.*

INTRODUCTION

The Friction stir welding (FSW) is a solid-state joining process which means that no molten state is included in joining or welding the respective workpiece. The technique which saves energy and is eco-friendly. This joining technique is mostly used to weld aluminum materials in the automobile and aerospace industries. The FSW process in which a tool is used in joining the workpiece and is not consumed so it is called a non-consumable tool. A non-consumable rotating tool which is having a pin and a shoulder that is inserted into the adjacent edges of sheets or plates to be joined and moved along the line of joint till the end. This process is considered to be the most significant development in the metal joining process. Also known as a “green” technology due to its energy efficiency, environment friendliness etc.

PRINCIPLE

A non-consumable tool is used to join the adjacent metal sheets which is made up of a pin and shoulder. This tool is used in Friction stir welding and is having two different functions of which the workpiece is heated to a temperature in which it is not molten but melted plastically and other function is to weld the workpiece it moves along the edges of the workpiece so that it is joined. The friction between the tool and the workpiece isthe heating is achieved by friction between the tool and the workpiece and because of the plastic deformation of the workpiece. The localized heating softens the material around the pin and shoulder. The tool rotation leads to the movement of material from the front of the pin to the back of the pin. And this completes the welding and a strong solid-state joint is ready.



LITERATURE REVIEW

Sahu and Pal [1] were carried out experiments by using Taguchi's L18 factorial design of experiment. Grey rational analysis was used for optimizing processes parameters. The Percentage effect of an individual process parameter is measured on the weld quality. They used AM20 Magnesium alloy to form square but joint. Process parameters were used tool rotation speed, welding speed, shoulder diameter and plunge depth. To find out ultimate tensile strength and yield the strength welding tensile test is calculated. The optimized process parameters were found to be plunge depth at 0.12 mm, welding speed at 98 mm/min, rotational speed at 1100 rev/min and shoulder diameter at 24mm.

Pankaj Neoget al. [2] were conducted welding on 6.35 mm thick plate of AA7075-T6 alloy using friction stir welding technique. The Square butt joint is used by him in the experiment as it found the better result. The process parameters are rotational speed, axial load and welding speed, also the output variable is tensile strength. The relationship between the load and tensile strength is positive the tensile strength is increased along with the axial load increase.

E. Fereiduniet al. [3] used Al-5083 and steel alloy St-12 alloy sheets with the thicknesses of 3 and 1 mm as a material for friction stir welding. At the joint interface the temperature was measured. To weld the material Rotational speeds of 900 and 1100 rpm were used with the dwell times of 5, 7, 10, 12 and 15 second. Then tensile and shear test are carried out on three specimens for each processing condition and the average values were recorded. They found that joint strength increases up to certain limit as dwell time increases and then start declining.

OBJECTIVE AND METHODOLOGY

The objective of the present research is to develop a finite element analysis with improved capability to predict strength evolution in aluminum alloys 70705&6065.to determine the optimal weld parameters using FEA and experimentally. Experiments have been conducted on the AA6065 and AA7075 in a vertical axis CNC milling machine by programming at different cutting tools (round, taper and Pentagonal). In this project to investigate the mechanical properties such as tensile, hardness and microstructure.

METHODOLOGY

In this work frictional stir welded Pure AA6065 and AA7075 specimens are compared for mechanical properties. In this study FSW specimens are prepared at 11mm/min feed rate and speeds are850rpm.

In this experiment plate size of aluminum and copper are same and having 160 mm length, 110 mm width and 5 mm thickness. H13 tool steel material is used to manufacture the tools. The tool has pin diameter of 6-millimeter size. Tool dimensions: Shoulder Diameter-18mm and Pin Diameter 6mm

The 3D modeling of FSW is designed in CREO.

In static analysis, to determine the stress, strain and deformation.

In thermal analysis, to determine the temperature distribution and heat flux.

MATERIALS AND RESPONSES

In this project we are taken work piece materials are aluminum alloy 6065 and aluminum alloy 7075 and tool material is HCHCr (High Carbon High Chromium steel)

AA6065:6065 Aluminum plate is a precipitation-hardened aluminum alloy containing magnesium and silicon as its major alloying elements. 6065 aluminum plate is one of the most versatile of the heat-treatable alloys. Also,6065 is popular for its medium to high strength requirements, good toughness and excellent corrosion resistance

AA7075:7075 is an aluminum alloy with zinc as the primary alloying element. It is strong, with a strength comparable to many steels, and has good fatigue strength and average machinability, but has less resistance to corrosion than many other Al alloys. 7075 is widely used in mold tool manufacture due to its high strength, low density, thermal properties and its ability to be highly polished.

HCHCr: D3 Steel Having 12 % ledeburite chromium tool steel with great wears resistance. Basically, utilized as cutting tools for sheets up to 4 mm thickness, trimming dies, blanking dies for paper and plastics, shear cutting edges and rotational shear edges for sheet thicknesses up to 2 mm.

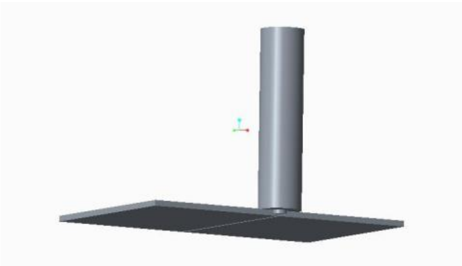
Tensile test: Tensile testing, which is also known as tension testing is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until it is a failure. Properties that are directly measured via a tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area. The following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics from these measurements

Brinell hardness (BH) test

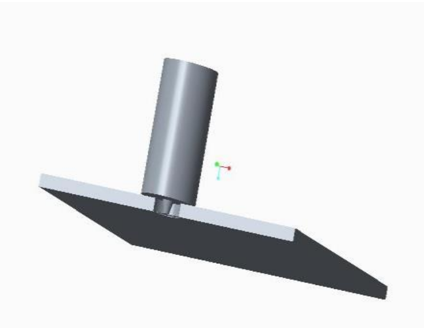
Method of measuring the hardness of a material by pressing a chromium-steel or tungsten-carbide ball (commonly one centimeter or 0.4 inch in diameter) against the smooth material surface under standard test conditions (such as between 300 to 3000 kilograms of force for 5 to 30 seconds). Here the hardness is expressed as Brinell Hardness Number (BHN) which is computed by dividing the load in kilograms by the area of indentation that is made by the ball measured in square millimeters.

SEM: A normal scanning electron microscope operates at a high vacuum. Here a beam of electrons is generated by a suitable source, typically a tungsten filament or a field emission gun is a basic principle. The electron beam is thoroughly accelerated through a high voltage (e.g.: 20 kV) and is passed through a system of apertures and electromagnetic lenses to produce a thin beam of electrons and then the beam scans the surface of the specimen by means of scan coils (like the spot in a cathode-ray tube "old-style "television).

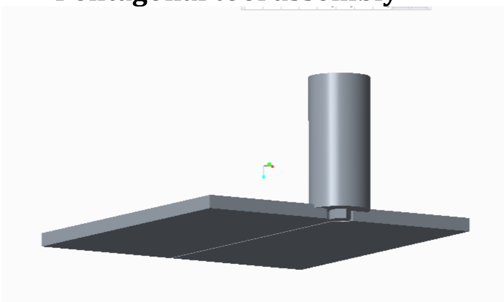
MODELING AND SIMULATION ROUND TOOL ASSM



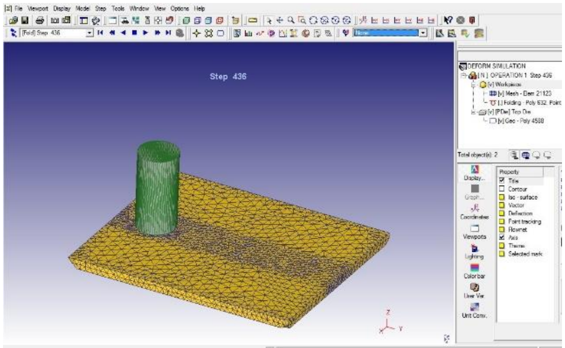
TAPER TOOL ASSEMBLY



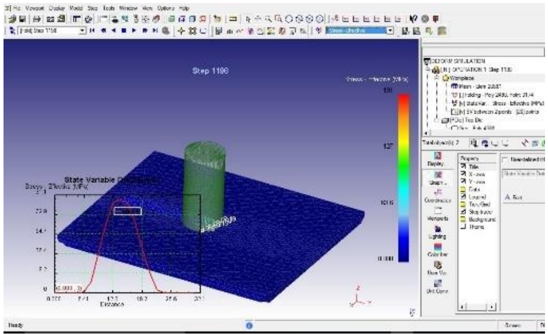
Pentagonal tool assembly



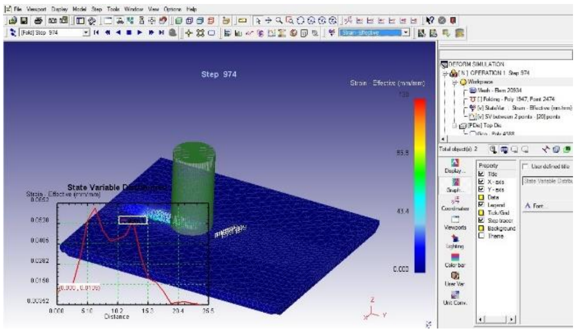
TOOL PROFILE -Pentagonal DEFORM-3D BASIC VIEW



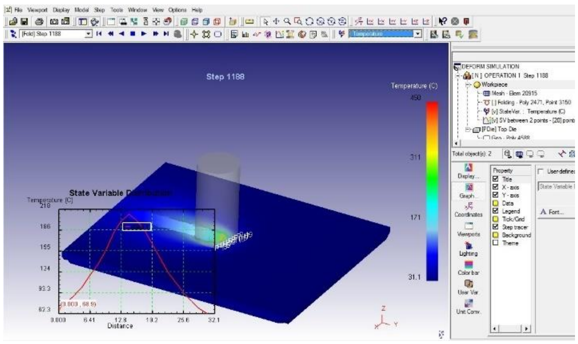
Stress



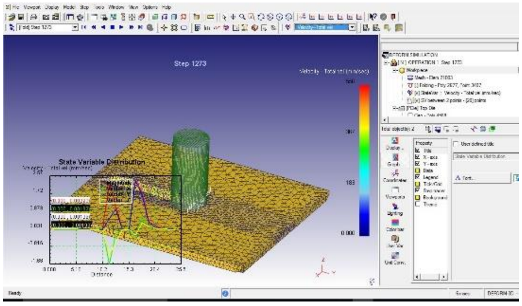
Shear stress



Temperature Distribution



Material Removal



EXPERIMENTAL INVESTIGATION

Experimental investigation is done to verify the mechanical properties of friction stir welding of aluminum alloy 7075and AA 6065. The properties investigated are tensile strength micro structure and hardness compared after welding.

On the Vertical CNC machine, the welding is done.

SPEED(rpm)	TOOL
850	ROUND
	TAPER
	PENTAGON

In this work, the process was done using a vertical milling machine which is having automatic feed. The respective experiments were conducted by the tool rotational speeds and the feeds that were set accordingly and the tool profiles are considered as Circular, Pentagonal and Taper.

Experimental Photos

Fig: friction stir welding process

Fig: tool position

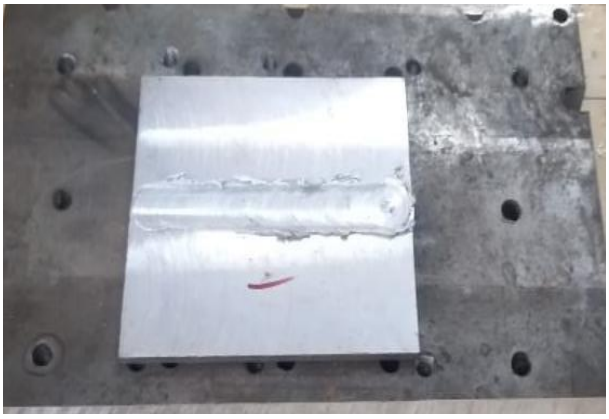


Fig: Final work piece

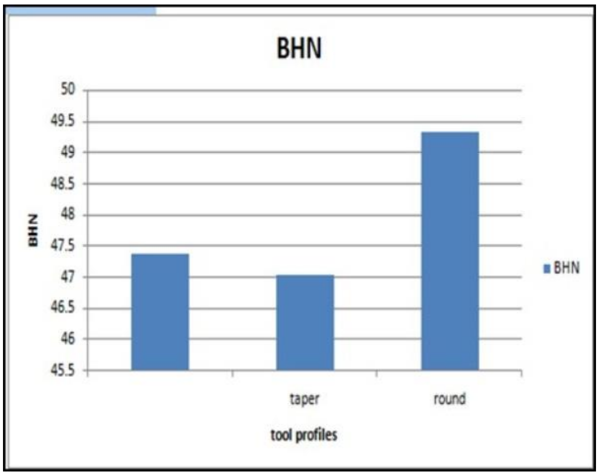
RESULTS AND DISCUSSIONS

Hardness test results

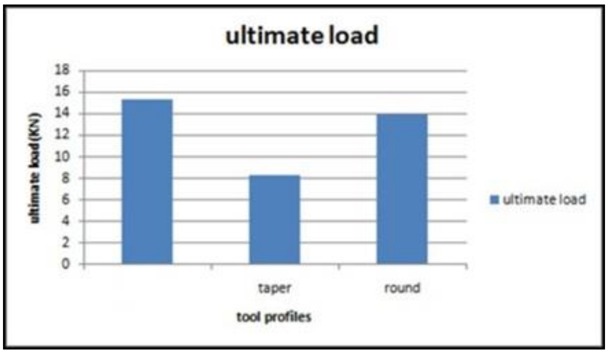
The hardness of the weld joins and composites was evaluated using Hardness Testing Machine, Mitutoya, Model of Japan with the no HM113 with HV 0.05 load and diamond indenter is used. The indentation time for hardness measurement was 15 seconds. An average of three readings was taken for each hardness value and were considered for plotting the graph as shown in the respective Figure

Tensile Test

According to the plot, the ultimate load increases at Pentagonal tool profile compared to other two tool profiles.



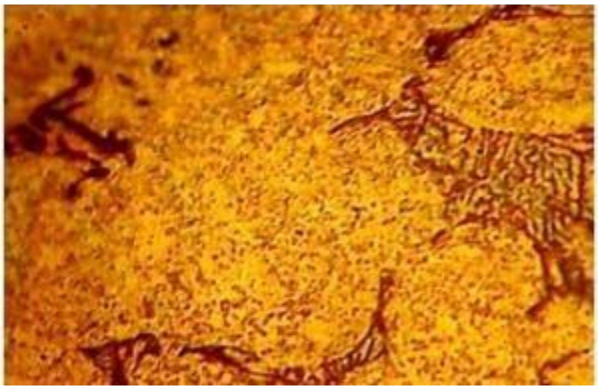
METALLOGRAPHIC ANALYSIS



Here optical and scanning electron microscopy (SEM) is used for the examination where Metallographic weld specimens were cut, mounted, polished and examined. SEM microscope that is used here was a JEOL JSM-6460 which is equipped with Oxford Instruments INCA-350 energy-dispersive spectroscopy system.

Sample 1-Pentagonal tool

Sample -2-taper tool



Sample-3-round tool

Micro structure of a prepared surface specimens tested by inverted metallurgical microscope range of 25X -500X magnification. Micro structure of polished surface resulted cluster formation of reinforcement particles as shown in the sample 1. Clear identification of non-metallic particles distribution in between metallic particles resulted by etching process as shown in the sample -2. The formation of dendritic structure resulted by solidification process observed before heat treatment of weld zone.

CONCLUSION

In this project different cutting tool pin profiles is designed for doing Friction Stir Welding of two dissimilar materials Aluminum alloy 7075 and AA6065 running at speeds 850rpm. Modeling is done in CREO.

Structural analysis is performed on the different tool pin profiles to verify the deformation and stresses.

Thermal analysis to determine the temperature distribution and heat flux.

By observing the static analysis results, stresses values are decreases at Pentagonal tool pin profile.

By observing the thermal analysis, the temperature values reduce at Pentagonal tool pin profile compared other tool pin profiles.

In this thesis, two plates of the Aluminum alloy 7075 and AA6065 are welded experimentally on a vertical CNC machine using 850rpm speed for cutting tool. Tensile strength, microstructure and hardness are evaluated after welding.

By observing the tensile test results, ultimate tensile strength values are increases by Pentagonal tool pin profile.

By observing the hardness test results, hardness values are increases by Pentagonal tool at weld zone.
So, it can be concluded the cutting Pentagonal tool pin profile is the better.

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